Efficient Capital Market with Predictable Asset Returns: Evidence from Private Commercial Real Estate Investments

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Executive Summary

This paper tests the hypothesis that investors' ex ante discount rates help predict (1) ex post investment returns and (2) ex post investment risk. Note that this hypothesis is consistent with the notion of efficient capital market, as a positive risk-return relationship would prevent the market from buying assets with higher expected returns and selling those with lower expected returns as long as returns are fair in compensating risk involved in investments

I use a proprietary dataset of commercial real estate investments maintained by the National Council of Real Estate Investment Fiduciaries for my analysis. The dataset provides detailed financial and operational information at the property level, which allows me to calculate acquisition cap rates, ex poste investment returns, and ex post income growth of 2,118 institutional grade commercial properties in 155 Core Business Statistic Areas (CBSAs) in the U.S. from 1999Q4 to 2014Q4.

In bivariate analyses, I find strong results that higher acquisition cap rates predict higher ex post total investment returns at the property level. A 1% increase in cap rates corresponds to approximately 1% increase in ex post investment returns. This result remains strong and robust after I control for the fixed effects of property types, locations, and acquisition times. This result is also robust when I use two alternative measures of cap rates, one of which uses gross rental income and the other uses net operating income. I also find that cap rates predict ex post income growth.

I then use a holding-period log-linear factor model to test (1) whether cap rates help predict ex post investment returns in the presence of standard equity market factors, and (2) whether cap rates predict the systematic risk of investments, which is measured with equity market betas. I find strong evidence that cap rates provide significant incremental explanatory power for (1) properties' ex post investment returns and (2) their equity market betas, in the presence of standard equity market factors and when fixed effects of property types, location, and acquisition time are controlled. These results corroborate the hypothesis of efficient market with predictable asset returns and risk.

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Abstract

This paper tests whether investors' ex ante discount rates help predict both ex post investment returns and risk. Such predictability can exist in efficient capital markets and may not be traded away. The private commercial real estate market is ideal for this test, because acquisition cap rates accurately measure investors' ex ante discount rates and measuring ex post investment returns and risk is straightforward. Using a unique proprietary dataset of 2,118 large commercial properties in the 1999 to 2014 period, I find that acquisition cap rates strongly predict cross sectional ex post investment returns at the property level, in bivariate settings and in the presence of usual equity market factors. I also find that cap rates have strong predicting power for ex post systematic risk of private commercial real estate investments.

Key words: Return predictability, efficient market hypothesis, and commercial real estate

JEL classification: G12, R33

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1. Introduction

In his American Finance Association presidential address, Cochrane (2011) summarizes the literature of asset pricing over the last 40 years by saying, "Previously, we thought returns were unpredictable, with variation in price-dividend ratios due to variation in expected cash flows. Now it seems all price-dividend variation corresponds to discount-rate variation (page 1047)." While there is an on-going debate on the relative importance of cash flow and discount rate news in affecting price-dividend ratios (See, e.g. Ang and Bekaert (2007), Larrain and Yogo (2008), Chen (2009), Jules H. V. Binsbergen and Koijen (2010), Chen, Da and Zhao (2014)), if price-dividend ratios, or whatever other variables, do reflect investors' ex ante discount rates, the ratios should help predict ex post investment returns as well as their risk, in both the short term and the long term and both temporal and cross-sectional settings, if investors are rational and do not make systematic mistakes. In other words, I hypothesize that investors' ex ante discount rates predict ex post investment returns and their risk. Note that the market can still be "efficient" despite the predictability of investment returns, as a positive risk-return relationship may prevent the market from buying assets with higher expected returns (and also higher risk) and selling those with lower expected returns (and also lower risk) if returns are "correct" in compensating risk involved.

Testing this hypothesis is challenging in both fixed income and equity markets. The first part of the hypothesis seems to be a "fact" in the fixed income market. Yield to maturity for bonds are directly related to investors' ex ante discount rates, as there is little variation in future cash flows unless there is default. Further, yield to maturity perfectly predicts the subsequent bond returns when there is no default. However, the second part of the hypothesis is difficult to test using deal level data. While bonds with higher yield are perceived to have higher risk, measuring ex post investment risk is difficult for individual bonds as default is a binary event for each bond.

Measuring ex ante discount rates is the central hurdle of testing the hypothesis in the equity market. Price-dividend ratios of stocks is a reasonable but not perfect variable in measuring equity investors' ex ante discount rates, and they indeed predict stock market performance, but mostly at the aggregate level and over the long run (see, e.g. Campbell and Shiller (1988)). It is plausible that price-dividend ratios are also driven by news on cash flow variation and may be driven by investors' sentiments; therefore, they may be too noisy measures of ex ante discount rates, and thus may not predict the cross-section of stock returns and not in the short term.

This paper tests the hypothesis of efficient market with predictable returns in the private commercial real estate market. This is not only because commercial real estate itself is a large asset class in the economy,[1] but also because the real estate market appears to be an ideal setting to test this hypothesis. First, capitalization rates (or cap rates), which are the ratio of operating income to property values, are the real estate market equivalent (reciprocal) of the price dividend ratios. Note that cap rates may more accurately reflect ex ante discount rates of real estate investors than price dividend ratios do for stock investors. Since public companies' dividends are "residual" cash flows after paying

[1] The estimated total market value of commercial real estate is about $2 trillion in 2005 according to Make Room for Real Estate, New York, Freeman and Company, LLC.

operating expenses, including rents, it is likely that there is less variation in rent cash flows than in dividends. Therefore, it is plausible that variation in cap rates is more likely due to discount rate news instead of dividend news, which suggests that cap rates may do a better job reflecting ex ante discount rates of real estate investors than price dividend ratios do for stock investors.

The second reason why the private real estate seems an ideal market to test the hypothesis is that future payoffs from commercial properties, not like those in the fixed income market, are time-varying. Therefore, it is easier to measure ex post risk in real estate investment returns, including their systematic risk. Comparing the private real estate market with the fixed income and equity markets suggests that economists may be able to more accurately measure investors' ex ante discount rates in the real estate market than in the equity market, and more directly measure ex post investment risk in the real estate market than in the bond market.

I use a unique proprietary dataset of commercial real estate investments maintained by the National Council of Real Estate Investment Fiduciaries for my analysis. The dataset provides detailed financial and operational information at the property level, which allows me to calculate acquisition cap rates, ex poste investment returns, and ex post income growth of 2,118 institutional grade commercial properties in 155 Core Business Statistic Areas (CBSAs) in the U.S. from 1999Q4 to 2014Q4.

In bivariate analyses, I find strong results that higher acquisition cap rates predict higher ex post investment returns at the property level. This predicting power is not only statistically but also economically significant. An increase of 100 basis points in net operating income cap rates corresponds to an increase of approximately 97 basis points in ex post annual total returns. This result is strong and robust after I control for fixed effects of property types (i.e. apartment, industrial, office, or retail), locations (the Core Business Statistical Areas where properties are located), and acquisition time. This result is also robust when I use two alternative measures of cap rates, one using gross rental income and the other using net operating income.

Also in bivariate analyses, consistent with the traditional wisdom, I find that cap rates predict ex post income growth. This predictability is also statistically and economically significant. An increase of 100 basis points in cap rates corresponds to about a decrease of 148 basis points in ex post net income growth rate. Cap rates' positive relationship with ex post investment returns and negative relationship with ex post income growth remain significant, when I relate cap rates to both investment returns and income growth.

I then use a holding-period log-linear factor model to test (1) whether cap rates predict the systematic risk of investments, which is measured with equity market beta, and (2) whether cap rates help explain ex post investment returns in the presence of standard equity market factors. The holding-period log-linear factor model is first adopted by Cochrane (2005) in investigating the risk and return of venture capital investments, and also used by Korteweg and Sorensen (2010), Driessen, Lin and Phalippou (2012), and

Franzoni, Nowak and Phalippou (2012) , and Peng (2015) for the estimation of factor loadings for private equity and commercial real estate. This model essentially aggregates a single-period log factor model across the holding period of each property, and then regresses properties' holding-period total returns to factors aggregated across each property's holding periods in a cross-sectional setting. Note that this method itself does not allow unconditional estimation of property-specific equity market beta, as there is only one holding period total return for each property. However, it allows the test on whether the equity market beta for each property is related to this property's attributes, which is its cap rate in our analysis.

I find strong evidence that cap rates provide significant incremental explanatory power for (1) properties' equity market beta and (2) properties' ex post investment returns, in the presence of standard equity market factors and when fixed effects of property types, location, and acquisition time are controlled. These results corroborate the hypothesis of efficient market with predictable asset returns, and are robust when I use both gross rental income cap rates and net operating income cap rates and properties that were sold or not sold, for which I used appraised values to calculate their 5-year investment returns.

The rest of this paper is organized as follows. Next section describes the data. The third section conducts bivariate analyses on the relationship between cap rates and ex post investment returns and income growth. The fourth section uses the holding-period factor model to test the predicting power of cap rates for properties' ex post investment returns and equity market beta in the presence of usual equity market factors. Robustness checks are also conducted. The last section concludes.

2. Data

This paper uses the proprietary dataset of the National Council of Real Estate Investment Fiduciaries (NCREIF). NCREIF is a not-for-profit real estate industry association, which collects, processes, and disseminates information on the operation and transactions of commercial real estate. Its database consists of about 33,000 institutional-grade properties owned or managed by NCREIF members in a fiduciary setting. The database provides property attributes, such as property type, location, size, etc., as well as quarterly property level operational and transactional information, including rental income, net operating income (NOI), acquisition cost, appraised values, etc. All cash flow variables are on an unlevered basis. The NCREIF property level data have been used in previous research such as Fisher and Goetzmann (2005) and Peng (2015).

I calculate two different capitalization rates for each property in the dataset whenever possible. One is based on gross rental income and the other is based on net operating income. Specifically, the net income cap rate $CAP.NOI_{i,t}$ for property i at the end of the quarter when it was acquired (say, quarter t) is the ratio of net operating income $NOI_{i,t}$ in the coming year (quarters $t+1$ to $t+4$) to the acquisition price of the property $P_{i,t}$.

$$CAP.NOI_{i,t} = \frac{\sum_{s=t+1}^{t+4} NOI_{i,s}}{P_{i,t}} \quad (1)$$

The gross rental income cap rate $CAP.RENT_{i,t}$ for property i at the end of the quarter t is the ratio of gross rental income $RENT_{i,t}$ in the coming year (quarters $t+1$ to $t+4$) to the acquisition price of the property $P_{i,t}$.

$$CAP.RENT_{i,t} = \frac{\sum_{s=t+1}^{t+4} RENT_{i,s}}{P_{i,t}} \tag{2}$$

For each property in the dataset that has been sold, I calculate the total return Modified Internal Rate of Returns (MIRR) using actual cash flows during their entire holding periods. The cash flows consist of the acquisition cost, net operating income, cash flows from partial sales, capital expenditures, and net sale proceeds. I construct a simple property-type-specific total return index and use their quarterly returns as both the financing rate and the reinvestment rate to calculate the MIRRs. When constructing such indices, I first use market values (or appraised values if market values are not available) at the beginning and the end of each quarter and the net cash flow (NOI plus partial sale minus Capital Expenditures) for each quarter to calculate the quarterly total return for each property. I then calculate the quarterly equal-weighted average total return for each property type.

If disposition decisions were related to investment performance, sold properties would be a selected sample and may lead to biased results. To mitigate this problem and to increase the sample size, for properties that were not sold, I calculate five-year holding period total return MIRRs using appraised values five years after acquisition (minus a selling cost calculated from the average ratio of net sale proceeds to gross sale proceeds for sold properties) as the net sale proceeds from simulated sales. This paper analyzes the pooled sample as well as the actual and simulated sales separately and finds robust results.

For each property, I also calculate the net operating income and gross rental income growth rates from the first year to the second year after acquisition whenever possible. I also calculate the geometric average annual NOI growth rate and gross rental income growth rate in the first five years after acquisition (year 5 income divided with year 1 income to the power of 1/5 and then minus 1).

I clean the data by excluding extreme outliers, which are most likely data errors, and requiring properties to have highly correlated cap rates, income growth, and MIRRs. Specifically, the final sample includes a property if (1) its net income and gross rental income cap rates are between 1% and 20% and highly correlated; (2) its annual total return MIRR and capital appreciation MIRR are between -10% and 25% and are highly correlated; and (3) its average five-year net income growth rate and five-year rental income growth rate (in annual rates) are between -20% and 20% and are highly correlated. I deem a property to have two highly correlated variables (e.g. two different measures of cap rates) if the residual from a linear regression of one variable against the other is within three standard deviations of all regression residuals. I require highly correlated variables to mitigate the effect of possible data errors on my analysis.

The final sample consists of 2,118 properties that were acquired between 1999Q4 and 2014Q4. I plot the number of properties in each quarter in Figure 1. Figures 2 to 4 plot the histograms of the gross rental income cap rates, net operating income cap rates, and total return annual MIRRs of all properties in the sample.

Panel A of Table 1 reports basic statistics of gross rental income cap rates, net income cap rates, average five-year growth rates of gross rental income, average five-year growth rates of net operating income, and total return MIRRs. Panel B of Table 1 reports their correlations. A few things are worth noting. First, gross rental income cap rates and net income cap rates are positively correlated. Second, gross rental income growth rates and net income growth rates are also positively correlated. Third, both cap rates are positively correlated with ex post total return MIRRs and negatively correlated with ex post income growth rates. This is consistent with the notion that cap rates reflect ex ante discount rates and investors' expectation of future income growth, and thus may help predict ex post investment returns and expected income growth.

3. Cap rates, ex post returns, and ex post income growth

3.1. Income predictability

I first investigate the predictability of commercial real estate income growth at the property level. The more predictable income growth is, the larger portion of variation in cap rates is likely due to variation in ex ante discount rates, and better measures are cap rates for discount rates.

There is anecdotal evidence for the predictability of income growth, particularly for institutional grade properties, which tend to have low vacancy rates and long lease terms. Potential buyers often have access to leases before making offers. Consequently, investors may have a reasonably good idea about future rents. Empirically, I analyze whether short-term income growth rates predicts long-term income growth rates. Such predictability helps justify the use of cap rates as measures of ex ante discount rates.

Specifically, I run a series of regressions of long-term income growth rates, which I measure with geometric averages of annual growth rates during the 5-year period after acquisition (year 5 income divided by year 1 income, with the power reduced to 1/5, and then minus 1), against short-term income growth rates, which is the growth rate of the income from the first year after acquisition to the second year. Table 2 report regression results. Panel A is for gross rental income and Panel B is for net operating income.

The first specification in both panels is a baseline linear regression of the long-term income growth rate against an intercept term and the short-term income growth rate. The result shows strong predictability of income growth at the property level. However, the results may be subject to a few biases. First, certain property types may have higher income growth rates in both the short-term and the long-term than other types. Second, both short-term and long-term growth rates could be higher in some Core Business Statistic Areas (CBSAs) than in other CBSAs. Third, both short-term and long-term income growth rates may be higher in certain periods than in other periods. All of the above may lead to a mechanic positive relationship between the short-term income growth rates and the long-term growth rates, which is not predictability of income growth at the property level.

I use property type dummies, CBSA dummies, and dummies for acquisition quarters to mitigate the three potential biases. Specification II includes property type dummies; specification III adds CBSA dummies; and specification IV adds time dummies. Results from all these three specifications provide robust and strong results showing that the short-term income growth rates have significant explanatory power for the long-term income growth rates. The adjusted R2 varies from 0.3 to 0.39 for gross rental income growth and 0.18 to 0.25 for net operating income growth. I also re-estimate specification IV for properties that were sold (specification V) and properties that were not sold (specification VI) separately, and the results are robust.

3.2. Cap rates and ex post investment returns

If investors are rational and make no systematic mistake, their ex ante discount rates should predict ex post investment returns. Therefore, if cap rates do reflect ex ante discount rates, they should have strong predicting power for ex post returns.

I measure ex post investment returns with annual total-return MIRRs over properties' holding periods. I regress these holding-period MIRRs against acquisition cap rates and a variety of control variables and report results in Table 3. Panel A of Table 3 uses gross rental income cap rates and Panel B uses net operating income cap rates. The first specification in both panels includes only an intercept term and the cap rate. It is apparent that acquisition cap rates have significant explanatory power for ex post MIRRs. The adjusted R-square is not trivial either – it equals 0.11 when I use gross rental income cap rates and 0.24 when I use net operating income cap rates.

However, it is worth noting that this regression may also be subject to potential biases discussed in the previous section. For example, assuming that some types of properties, say apartments, are perceived by investors as having higher risk and, as a result, tend to have higher cap rates and also higher returns than other types, pooling different types of properties in the same regression may lead to significant explanatory power of cap rates for returns, which, however, does not suggest predictability of investment returns of individual properties.

I use property type dummies, CBSA dummies, and dummies for acquisition quarters in regressions to mitigate the potential biases discussed above. Specification II includes property type dummies; specification III adds CBSA dummies; and specification IV adds time dummies. Results from all these three specifications provide robust and strong results showing that cap rates have statistically significant explanatory power for ex post investment returns.

The predicting power is also economically significant. For example, in specification IV, which controls for all three types of dummies, an increase of 100 basis points in gross rental income cap rate predicts an increase of about 60 basis points in the ex post annual MIRR, and an increase of 97 basis points in the net operating income cap rate predicts about an increase of 104 basis points in the ex post annual MIRR. I also replicate specification IV using properties that were sold (specification V) and properties that were not sold (specification VI) separately, and the results remain robust and strong.

3.3. Cap rates, ex post investment returns, and ex post income growth

Cap rates reflect investors' expected future income growth (see, e.g. Campbell and Shiller (1988) and many others); therefore, they should predict ex post future income growth should investors have rational expectation. I test this by running regressions of ex post average long-term (5-year) income growth rate after acquisition against acquisition cap rates. We use the same four specifications used in Tables 2 and 3. The first one includes an intercept term and the cap rate. The second, third, and fourth specifications add property type dummies, CBSA dummies, and acquisition quarter dummies, to control for mechanic relationships due to correlated income growth and cap rates across property types, location, and time.

I report the results in Table 4, Panel A of which uses gross rental income cap rates and Panel B uses net operating income cap rates. The results clearly support the notion that higher acquisition cap rates predict lower ex post income growth. The adjusted R-square ranges from 0.06 to 0.25 for gross rental income cap rates and 0.15 to 0.24 for net operating income cap rates. After including dummy variables, the predicting power of cap rates remains statistically significant and appears to increase with more fixed effects being controlled. The predicting power is also economically significant. For example, in specification IV, which includes all three types of dummies, an increase of 100 basis points in cap rate predicts a decrease of 79 basis points in ex post income growth rate for gross rental income and a decrease of 148 basis points for net operating income. Overall, commercial real estate cap rates do predict ex post income growth.

This section finally relates cap rates to both ex post investment returns and income growth. Specifically, I regress acquisition cap rates against both ex post holding period annual total return MIRRs and 5-year average income growth rates, and report results in Table 5. I also use the same six specifications used in Tables 2 to 4 and use gross rental income cap rates in Panel A and use net operating income cap rates in Panel B.

All specifications in both panels provide consistent and statistically and economically significant results. Cap rates are positively correlated with ex post investment returns and negatively correlated with ex post income growth. The adjusted R-square increases when more dummy variables are included in the specification, and reaches 0.48 in Panel B and 0,56 in Panel B. These results indicate that investors seem to have rational expectations as cap rates, which reflect investors' ex ante discount rate and expected future income growth, are significantly related to ex post investment returns and income growth.

4. Cap rates and ex post systematic risk

4.1. Research design

Now I test (1) whether cap rates still predict ex post investment returns in the presence of standard equity market risk factors, and (2) whether cap rates predict ex post systematic risk of commercial real estate investments, which I measure with the equity market beta.

Note that it is infeasible to directly estimate beta for each property as I only observe holding period MIRRs. Therefore, I conduct both tests using the holding-period-return regression that was first adopted by Cochrane (2005) in estimating CAPM beta of venture capital investments, also used by Korteweg and Sorensen (2010), Driessen, Lin and Phalippou (2012), and Franzoni, Nowak and Phalippou (2012) for the estimation of factor loadings for private equity, and used by Peng (2015) for private commercial real estate.

The regression is built on a single-period log-linear factor model. Consider a property i that was acquired in period buy_i and sold in period $sell_i$. I assume the unobserved single-period investment return for this property in period t, $SR_{i,t}$, is generated from the following log-linear factor model,

$$\log\left(SR_{i,t}\right)-\log\left(RF_t\right)=\alpha+\sum_{k=1}^{K}\beta_k FA_{k,t}+\upsilon_{i,t}\ , \tag{3}$$

where RF_t is the risk-free interest rate, $FA_{k,t}$ are k factors, and $\upsilon_{i,t}$ is an error term.

It is apparent that the dependent variable in this model, the single period return, is typically unobserved. To obtain observed dependent variable, I aggregate both sides of equation (3) across each period within the property's holding period, which leads to the following equation.

$$\begin{aligned}&\sum_{t=buy_i+1}^{sell_i}\log\left(SR_{i,t}\right)-\sum_{t=buy_i+1}^{sell_i}\log\left(RF_t\right)\\&=\alpha\left(sell_i-buy_i\right)+\sum_{k=1}^{K}\left(\beta_k\sum_{t=buy_i+1}^{sell_i}FA_{k,t}\right)+\sum_{t=buy_i+1}^{sell_i}\upsilon_{i,t}\end{aligned} \tag{4}$$

I simplify the notation by defining the duration of the holding period, DU_i, as

$$DU_i = sell_i - buy_i . \tag{5}$$

I denote by CR_i the cumulated return of the property across its entire holding period, which can be calculated using the total return MIRR as follows.

$$CR_i \triangleq \sum_{t=buy_i+1}^{sell_i} \log\left(SR_{i,t}\right) = DU_i \times \log\left(MIRR_i\right). \tag{6}$$

I further simplify the notation for the error term as follows.

$$\sum_{t=buy_i+1}^{sell_i} \upsilon_{i,s} = \varepsilon_i . \tag{7}$$

I also add an intercept term to capture possible non-temporal return components, which include expenses of renovation after the acquisition and/or before the final sale and selling costs (see Goetzmann and Spiegel (1995) for evidence of non-temporal return component for residential properties). The model is now

$$\begin{aligned} &CR_i - \sum_{s=buy_i+1}^{sell_i} \log\left(RF_t\right) \\ &= \tau + \alpha DU_i + \sum_{k=1}^{K}\left(\beta_k \sum_{s=buy_i+1}^{sell_i} FA_{k,t}\right) + \varepsilon_i. \end{aligned} \tag{8}$$

Apparently, the model in (8) does not allow the estimation of property-specific factor loadings. However, it does allow me to test whether properties' equity market beta are correlated with properties' acquisition cap rates. Specifically, if a property's beta is correlated with the property's acquisition cap rate CAP_i, say

$$\beta_{capm}^{i} = \beta_{capm} + \rho CAP_i, \text{ with } \rho>0 , \tag{9}$$

I plug (9) in to (8) and the model becomes

$$
\begin{aligned}
&CR_i - \sum_{T=buy_i+1}^{sell_i} \log\left(RF_t\right) \\
&= \tau + \alpha DU_i + \left(\beta_{capm} + \rho CAP_i\right) \times \sum_{t=buy_i+1}^{sell_i} RmRf_t + \sum_{k=other}\left(\beta_k \sum_{t=buy_i+1}^{sell_i} FA_{k,t}\right) + \varepsilon_i \quad (10) \\
&= \tau + \alpha DU_i + \rho CAP_i \sum_{t=buy_i+1}^{sell_i} RmRf_t + \sum_{k=i}^{K}\left(\beta_k \sum_{t=buy_i+1}^{sell_i} FA_{k,t}\right) + \varepsilon_i .
\end{aligned}
$$

If ρ, which is the coefficient of the interaction term between the acquisition cap rate and the holding-period aggregate of the stock market risk premium $RmRf_t$, is statistically significant and positive, the null hypothesis is rejected. As a result, I would conclude that properties' acquisition cap rates, which proxy for ex ante discount rates, predict the ex post systematic risk of real estate investment returns.

4.2. Empirical results

I first test whether cap rates predict properties' equity market beta in a 4-factor model. The four factors are the Fama and French (1993) factors and the Pastor and Stambaugh (2003) liquidity factor. The first specification serves as a benchmark, which includes a non-temporal intercept term, the duration of a property's holding period (in quarters), which captures per-period alpha, and the four factors. The second and the third specification include the interaction term between the demeaned cap rate (gross rental income cap rate for the second specification and net operating income cap rate for the third specification) and the stock market risk premium. The null hypothesis I test is that cap rates do not predict ex post equity market beta, which means the coefficients of the interaction terms are 0.

Two details are worth noting. First, we use demeaned cap rates because cap rates are positive numbers. If cap rates are positively correlated with market beta and commercial real estate have positive market beta, including the interaction between cap rates and stock market risk premium in the regressions would mechanically force the intercept term to be negative. Demeaned cap rates, on the other hand, would not artificially bias the intercept.

Second, should the error term in the single-period model (equation 3) be i.i.d., the variance of the error term in the holding-period model (equation 10) should increase with the duration of the holding period. A standard approach (e.g. Case and Shiller (1989)) to address this is to estimate the holding period model using OLS as the first stage, regress OLS residuals against the duration, and then use the fitted values of residuals as weights to run weighted OLS in the second stage. However, I find that OLS residuals are negatively related to duration, and this relationship is statistically significant but not economically significant (coefficient is less than 0.001). This suggests that the error term in the single-period model likely have negative autocorrelation. Therefore, in all reported results, I run OLS and calculate and report White's heteroscedasticity-consistent standard deviations.

Table 6 reports regression results. Specification one indicates a -5.6% non-temporal return component, which, however, is offset by a 0.3% per-period alpha. This seems to suggest that properties with holding periods longer (shorter) than 19 quarters will have positive (negative) risk adjusted returns (-5.6% plus 0.3% times 19) during their holding periods. However, it is worth noting that this result is sensitive to how I trim the sample by tossing extreme outliers. Therefore, it may be wise not to over-interpret the intercept and the per-period alpha. Specification one also suggests a small positive market beta (0.171), an insignificant SMB loading, a small positive HML loading (0.217), and a small positive loading of liquidity (0.252). The adjusted R2 is 0.15.

Specifications 2 and 3 provide very strong evidence for statistically and economically significant predicting power of cap rates for ex post equity market beta. The coefficient of the interaction term is 5.541 in specification 2 and 10.999 in specification 3. This means that an increase of 100 basis points in gross rental income cap rate would increase beta by 0.06, and the same increase in net operating income cap rate would increase beta by about 0.11. To investigate if the results are robust across sold and unsold properties, I replicate the second and the third specifications in Table 6 for sold and unsold properties respectively and report the results in Table 7. It is apparent that the results are robust. Note that due to identical holding periods (5 years) of unsold properties I use to calculate their MIRRs, duration and the intercept term are perfectly correlated so they do not have estimated coefficients in Table 7.

The results in Tables 6 and 7 are consistent with the notion that cap rates predict ex post investment risk. However, the coefficient of the interaction term might be biased upwards due to missing real estate factors, especially those at the property level, that are correlated with both the interaction term and investment returns. One candidate of such factors is cap rate itself. As I argue earlier, cap rates likely reflect investors' ex ante discount rates, which may be affected by not only market risk but also property-specific risk. As a result, cap rates may not only predict ex post investment returns, but also supplement equity market risk factors in explaining commercial real estate investment risk premium in factor models.

I then estimate two more specifications of the 4-factor model. The first includes demeaned cap rates and the second further includes the interaction term between demeaned cap rates and stock market risk premium. These specifications serve two purposes. The first specification allows me to test whether the predicting power of cap rates for ex post investment returns remains strong in the presence of the four equity market factors. The second specification allows me to investigate whether the predicting power of cap rates for ex post beta remains significant when real estate specific factors, which I use cap rates to capture, are controlled.

A detail is worth noting. Cap rates are calculated using annual income and they are expected to predict ex post returns per period, but the dependent variable in the regressions is total returns over the entire holding period. To make these two variables comparable with each other, I scale the demeaned cap rate by multiplying it with the number of quarters in the duration (or the number of years alternatively). As a result, the coefficient of the scaled demeaned cap rate has a more natural interpretation, which is the effect of cap rates on quarterly investment returns.

Table 8 reports the results. It is apparent that the predicting power of cap rates for ex post investment returns remains strong in the presence of the four equity market factors. Specifically, when the interaction term is not included in the model, an increase of 100 basis points in the gross rental income cap rates would increase commercial real estate risk premium by about 9 basis points per quarter or about 36 basis points per annum. An increase of 100 basis points in the net operating income cap rates would increase the risk premium by about 20 basis points per quarter or about 80 basis points per annum. When the interaction term is included, the effects are slightly weaker but still economically significant: 7 basis points per quarter (28 basis points per annum) for gross rental income cap rates and 18 basis points per quarter (72 basis points per annum) for net operating income cap rates.

The results also indicate that cap rates strongly predict ex post equity market beta of commercial real estate investments, even when I include the demeaned and scaled cap rates directly in the regressions to control for possible real estate factors. Specifically, an increase of 100 basis points in gross rental income cap rates would increase market beta by 0.02. An increase of 100 basis points in net operating income cap rates would increase market beta by 0.025. Finally, it is worth noting that both the non-temporal return component and the per-period alpha become insignificant in Table 8. This suggests that alpha estimates are very sensitive to factors used and possible real estate factors may play significant roles in pricing commercial properties.

Finally, I use a model that includes not only the four stock market factors but also a variety of dummies to further investigate whether cap rates have robust predicting power for ex post investment returns and ex post equity market beta. The model uses dummies for property types, CBSAs, and acquisition periods to further control for possible mechanic relationships between cap rates and ex post returns and beta. It is important to note that these models are not factor models; consequently, both the intercept term and the coefficient of holding period duration should not be interpreted as alpha estimates.

Table 9 reports the results of three specifications for both gross rental income cap rates and net income cap rates. In addition to the four stock market factors as well as the dummies, the first includes the scaled demeaned cap rates; the second includes the interaction between the demeaned cap rate and the stock market risk premium; and the third include both. It is apparent that cap rates continue to have both statistically and economically significant explanatory power for ex post investment risk premium. For example, in the first and the last specifications, an increase of 100 basis points in gross rental income cap rates would predict an increase of 13 or 11 basis points per quarter (52 to 44 basis points per annum) in ex post risk premium. At the same time, an increase of 100 basis points in net operating income cap rates would predict an increase of 22 or 19 basis points per quarter (88 to 76 basis points per annum) in ex post risk premium.

The predicting power of cap rates for ex post equity market beta remains strong at the 1% level in specification II but only strong at the 10% level in specification III where cap rates are also included. The economic impact of the predicting power remains significant. Even in specification III, when the magnitude of the impact is smaller, an increase of 100 basis points in gross rental income cap rates would increase market beta by 0.017, and the same increase in net operating income cap rates would increase market beta by 0.021. Overall, it seems fair to conclude that cap rates reliably and strongly predict ex post investment returns and their equity market beta, even after I control for possible mechanic relationships due to heterogeneity across property types, locations, and acquisition time.

5. Conclusions

This paper tests the hypothesis that rational investors' ex ante discount rates predict both ex post asset returns and their systematic risk. Such predictability is consistent with the notion of efficient capital markets and should not be traded away as returns are expected to compensate rational investors for the risk they bear. Using property level data of 2,118 institutional-grade commercial real estate invested in the 1999Q4 to 2014Q4 period, I find strong evidence that acquisition cap rates strongly predict cross sectional ex post investment returns, in bivariate settings and in the presence of usual equity market factors. I also find that cap rates have strong predicting power for ex post systematic risk of commercial real estate investments, which is measured with their equity market beta. These results are robust when property types, locations, and acquisition time are controlled.

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Table 1. Data summary

This table reports summary statistics for gross rental income cap rates, net operating income cap rates, average annual growth rate of gross rental income during the 5-year period after acquisition, average annual growth rate of net operating income during the 5-year period after acquisition, average annual total return in modified IRR during holding period, as well as their correlations with each other.

	Cap rate (gross income)	Cap rate (net income)	Income growth (gross income)	Income growth (net income)	Annual modified IRR
Panel A. Statistics					
Mean	8.78%	6.73%	2.82%	2.62%	5.07%
Standard dev.	2.94%	2.35%	5.64%	7.26%	5.74%
Minimum	2.37%	1.07%	-18.39%	-19.46%	-7.37%
Median	8.33%	6.38%	2.78%	2.56%	5.03%
Maximum	19.95%	17.64%	19.80%	19.99%	24.95%
Panel B. Correlations					
Cap rate (gross income)	1	0.68	-0.26	-0.22	0.33
Cap rate (net income)		1	-0.35	-0.39	0.49
Income growth (gross income)			1	0.87	-0.02
Income growth (net income)				1	-0.01

Table 2. Predicting long-term income growth with short-term income growth

The table reports regressions of geometric average annual income growth during the 5-year period after acquisition against the annual income growth during the first year after acquisition. Income is measured with gross rental income in panel A and net operating income in panel B. Regressions V and VI have the same specifications with regression IV but use properties that were sold and not sold respectively. White's heteroscedasticity-consistent standard deviations are reported in parentheses. ***, **, and * indicate significant levels of 1%, 5%, and 10% respectively.

Panel A: average growth of gross rental income in 5 years						
	I	II	II	IV	V	VI
Year 1 income growth	0.153***	0.149***	0.146***	0.145***	0.131***	0.153***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.011)	(0.010)
Dummy: type	No	Yes	Yes	Yes	Yes	Yes
Dummy: CBSA	No	No	Yes	Yes	Yes	Yes
Dummy: quarter	No	No	No	Yes	Yes	Yes
Sample size	2,116	2,116	2,116	2,116	997	1,119
Adjusted R2	0.30	0.32	0.33	0.36	0.32	0.39
Panel B: average growth of net operating income in 5 years						
	I	II	II	IV	V	VI
Year 1 income growth	0.108***	0.108***	0.108***	0.105***	0.133***	0.147***
	(0.012)	(0.011)	(0.011)	(0.012)	(0.014)	(0.012)
Dummy: type	No	Yes	Yes	Yes	Yes	Yes
Dummy: CBSA	No	No	Yes	Yes	Yes	Yes
Dummy: quarter	No	No	No	Yes	Yes	Yes
Sample size	2,108	2,108	2,108	2,108	993	1,115
Adjusted R2	0.18	0.21	0.21	0.24	0.18	0.25

Table 3. Predicting future returns with cap rates

The table reports regressions of annual total returns (in modified IRRs) in future holding periods against acquisition cap rates, which are calculated using total rental income in panel A and net operating income in panel B. Regressions V and VI have the same specifications with regression IV but use properties that were sold and not sold respectively. White's heteroscedasticity-consistent standard deviations are reported in parentheses. ***, **, and * indicate significant levels of 1%, 5%, and 10% respectively.

Panel A						
	I	II	II	IV	V	VI
Acquisition cap rate	0.648***	0.792***	0.884***	0.597***	0.569***	0.693***
	(0.044)	(0.049)	(0.055)	(0.057)	(0.080)	(0.087)
Dummy: type	No	Yes	Yes	Yes	Yes	Yes
Dummy: CBSA	No	No	Yes	Yes	Yes	Yes
Dummy: quarter	No	No	No	Yes	Yes	Yes
Sample size	2,118	2,118	2,118	2,118	998	1,120
Adjusted R2	0.11	0.16	0.20	0.31	0.33	0.37
Panel B						
	I	II	II	IV	V	VI
Acquisition cap rate	1.187***	1.235***	1.315***	0.971***	0.881***	1.042***
	(0.064)	(0.070)	(0.071)	(0.075)	(0.104)	(0.111)
Dummy: type	No	Yes	Yes	Yes	Yes	Yes
Dummy: CBSA	No	No	Yes	Yes	Yes	Yes
Dummy: quarter	No	No	No	Yes	Yes	Yes
Sample size	2,118	2,118	2,118	2,118	998	1,120
Adjusted R2	0.24	0.24	0.28	0.35	0.36	0.41

Table 4. Predicting long term income growth with cap rates

The table reports regressions of average annual income growth during the 5-year period after acquisition against acquisition cap rates. Both income growth and cap rates are calculated with gross rental income in panel A and net operating income in panel B. Regressions V and VI have the same specifications with regression IV but use properties that were sold and not sold respectively. White's heteroscedasticity-consistent standard deviations are reported in parentheses. ***, **, and * indicate significant levels of 1%, 5%, and 10% respectively.

Panel A						
	I	II	II	IV	V	VI
Acquisition cap rate	-0.49***	-0.63***	-0.68***	-0.79***	-0.73***	-0.91***
	(0.04)	(0.05)	(0.05)	(0.06)	(0.08)	(0.09)
Dummy: type	No	Yes	Yes	Yes	Yes	Yes
Dummy: CBSA	No	No	Yes	Yes	Yes	Yes
Dummy: quarter	No	No	No	Yes	Yes	Yes
Sample size	2,118	2,118	2,118	2,118	998	1,120
Adjusted R2	0.06	0.13	0.17	0.23	0.22	0.25

Panel B						
	I	II	II	IV	V	VI
Acquisition cap rate	-1.20***	-1.16***	-1.24***	-1.48***	-1.51***	-1.52***
	(0.07)	(0.08)	(0.08)	(0.10)	(0.15)	(0.14)
Dummy: type	No	Yes	Yes	Yes	Yes	Yes
Dummy: CBSA	No	No	Yes	Yes	Yes	Yes
Dummy: quarter	No	No	No	Yes	Yes	Yes
Sample size	2,118	2,118	2,118	2,118	998	1,120
Adjusted R2	0.15	0.15	0.16	0.22	0.21	0.24

Table 5. Relating cap rates to both future returns and future income growth

The table reports regressions of acquisition cap rates against annual total returns (in modified IRR) in future holding periods and average annual income growth during the 5-year period after acquisition. Both cap rates and income growth are calculated with gross rental income in panel A and net operating income in panel B. Regressions V and VI have the same specifications with regression IV but use properties that were sold and not sold respectively. White's heteroscedasticity-consistent standard deviations are reported in parentheses. ***, **, and * indicate significant levels of 1%, 5%, and 10% respectively.

	Panel A					
	I	II	II	IV	V	VI
Future return	0.17***	0.19***	0.19***	0.14***	0.14***	0.15***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
Future income growth	-0.13***	-0.16***	-0.16***	-0.16***	-0.15***	-0.16***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Dummy: type	No	Yes	Yes	Yes	Yes	Yes
Dummy: CBSA	No	No	Yes	Yes	Yes	Yes
Dummy: quarter	No	No	No	Yes	Yes	Yes
Sample size	2,118	2,118	2,118	2,118	998	1,120
Adjusted R2	0.17	0.33	0.42	0.48	0.54	0.48
	Panel B					
	I	II	II	IV	V	VI
Future return	0.20***	0.19***	0.19***	0.15***	0.14***	0.16***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Future income growth	-0.13***	-0.11***	-0.11***	-0.11***	-0.11***	-0.12***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Dummy: type	No	Yes	Yes	Yes	Yes	Yes
Dummy: CBSA	No	No	Yes	Yes	Yes	Yes
Dummy: quarter	No	No	No	Yes	Yes	Yes
Sample size	2,118	2,118	2,118	2,118	998	1,120
Adjusted R2	0.39	0.44	0.50	0.56	0.58	0.58

Table 6. Cap rate and equity market beta

The table reports regressions of property level holding period gross total return risk premium against an interaction term between the stock market risk premium and demeaned cap rate, the Fama-French factors, and the liquidity factor. White's heteroscedasticity-consistent standard deviations are reported in parentheses. ***, **, and * indicate significant levels of 1%, 5%, and 10% respectively.

	I	II	III
Intercept	-0.056**	-0.034	-0.037
	(0.027)	(0.028)	(0.027)
Duration	0.003**	0.003**	0.005***
	(0.001)	(0.001)	(0.001)
Cap rate * RmRf		5.541***	10.999***
		(0.774)	(0.979)
RmRf	0.171***	0.150***	0.092***
	(0.029)	(0.028)	(0.027)
SMB	0.080	0.067	0.050
	(0.088)	(0.088)	(0.087)
HML	0.217***	0.270***	0.308***
	(0.056)	(0.056)	(0.056)
Liquidity	0.252***	0.190***	0.117***
	(0.031)	(0.032)	(0.033)
Sample size	2,118	2,118	2,118
Adjusted R2	0.15	0.18	0.22

Table 7. Cap rate and equity market beta: sold and unsold properties

The table reports regressions of property level holding period gross total return risk premium against the interaction term between the stock market risk premium and the demeaned cap rate, the Fama-French factors, the liquidity factor for sold and unsold properties respectively. White's heteroscedasticity-consistent standard deviations are reported in parentheses. ***, **, and * indicate significant levels of 1%, 5%, and 10% respectively.

	Gross income cap rates		Net income cap rates	
	I: sold	II: unsold	I: sold	II: unsold
Intercept	-0.152***	0.098***	-0.141***	0.122***
	(0.049)	(0.025)	(0.049)	(0.026)
Duration	0.004*	NA	0.006**	NA
	(0.002)		(0.002)	
Cap rate * RmRf	5.639***	5.383***	12.196***	8.288***
	(0.983)	(1.196)	(1.352)	(1.388)
RmRf	0.224***	0.134***	0.142**	0.096***
	(0.063)	(0.031)	(0.065)	(0.031)
SMB	0.423***	-0.264**	0.427***	-0.286***
	(0.146)	(0.103)	(0.144)	(0.104)
HML	0.290***	0.317***	0.302***	0.346***
	(0.095)	(0.062)	(0.096)	(0.064)
Liquidity	0.100	0.194***	0.022	0.144***
	(0.061)	(0.039)	(0.065)	(0.041)
Sample size	2,118	2,118	2,118	2,118
Adjusted R2	0.20	0.15	0.25	0.16

Table 8. Cap rate and equity market beta: real estate factors

The table reports regressions of property level holding period gross total return risk premium against the demeaned cap rate, an interaction term between the stock market risk premium and the demeaned cap rate, the Fama-French factors, and the liquidity factor. White's heteroscedasticity-consistent standard deviations are reported in parentheses. ***, **, and * indicate significant levels of 1%, 5%, and 10% respectively.

	Gross income cap rates		Net income cap rates	
	I	II	I	II
Intercept	-0.006	-0.009	-0.001	-0.004
	(0.029)	(0.029)	(0.028)	(0.028)
Duration	0.001	0.002	0.003**	0.003**
	(0.001)	(0.001)	(0.001)	(0.001)
Cap rate * Duration	0.088***	0.070***	0.199***	0.175***
	(0.011)	(0.012)	(0.015)	(0.017)
Cap rate * RmRf		2.049***		2.470**
		(0.849)		(1.140)
RmRf	0.183***	0.172***	0.157***	0.141***
	(0.028)	(0.028)	(0.027)	(0.028)
SMB	0.113	0.101	0.144*	0.129
	(0.088)	(0.088)	(0.085)	(0.085)
HML	0.153***	0.186***	0.112**	0.145**
	(0.055)	(0.057)	(0.054)	(0.057)
Liquidity	0.203***	0.190***	0.119***	0.104***
	(0.031)	(0.032)	(0.032)	(0.033)
Sample size	2,118	2,118	2,118	2,118
Adjusted R2	0.19	0.19	0.26	0.26

Table 9. Cap rate and equity market beta: dummy model

The table reports regressions of property level holding period gross total return risk premium against the demeaned cap rate, an interaction term between the stock market risk premium and the demeaned cap rate, the Fama-French factors, the liquidity factor, and a variety of dummy variables. White's heteroscedasticity-consistent standard deviations are reported in parentheses. ***, **, and * indicate significant levels of 1%, 5%, and 10% respectively.

	Gross income cap rates			Net income cap rates		
	I	II	III	I	II	III
Intercept	0.681***	0.722***	0.705***	0.729***	0.799***	0.758***
	(0.173)	(0.180)	(0.220)	(0.169)	(0.177)	(0.170)
Duration	0.004	0.006*	0.004	0.006**	0.007**	0.006**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Cap rate * Duration	0.125***		0.109***	0.215***		0.194***
	(0.013)		(0.013)	(0.017)		(0.019)
Cap rate * RmRf		6.579***	1.710*		10.727***	2.137*
		(0.884)	(0.930)		(1.132)	(1.281)
RmRf	0.197**	0.169**	0.195**	0.157**	0.129	0.152*
	(0.080)	(0.082)	(0.075)	(0.078)	(0.081)	(0.078)
SMB	0.018	-0.033	0.003	-0.099	-0.080	0.109
	(0.026)	(0.262)	(0.227)	(0.258)	(0.263)	(0.259)
HML	-0.497***	-0.481**	-0.498**	-0.484**	-0.474**	-0.485**
	(0.417)	(0.219)	(0.202)	(0.212)	(0.219)	(0.213)
Liquidity	-0.032	0.029	0.004	-0.021	-0.039	-0.035
	(0.058)	(0.105)	(0.097)	(0.101)	(0.104)	(0.102)
Dummy: type	Yes	Yes	Yes	Yes	Yes	Yes
Dummy: CBSA	Yes	Yes	Yes	Yes	Yes	Yes
Dummy: quarter	Yes	Yes	Yes	Yes	Yes	Yes
Sample size	2,118	2,118	2,118	2,118	2,118	2,118
Adjusted R2	0.28	0.25	0.28	0.32	0.27	0.32

Figure 1. Sample properties in each quarter from 1999Q4 to 2014Q4

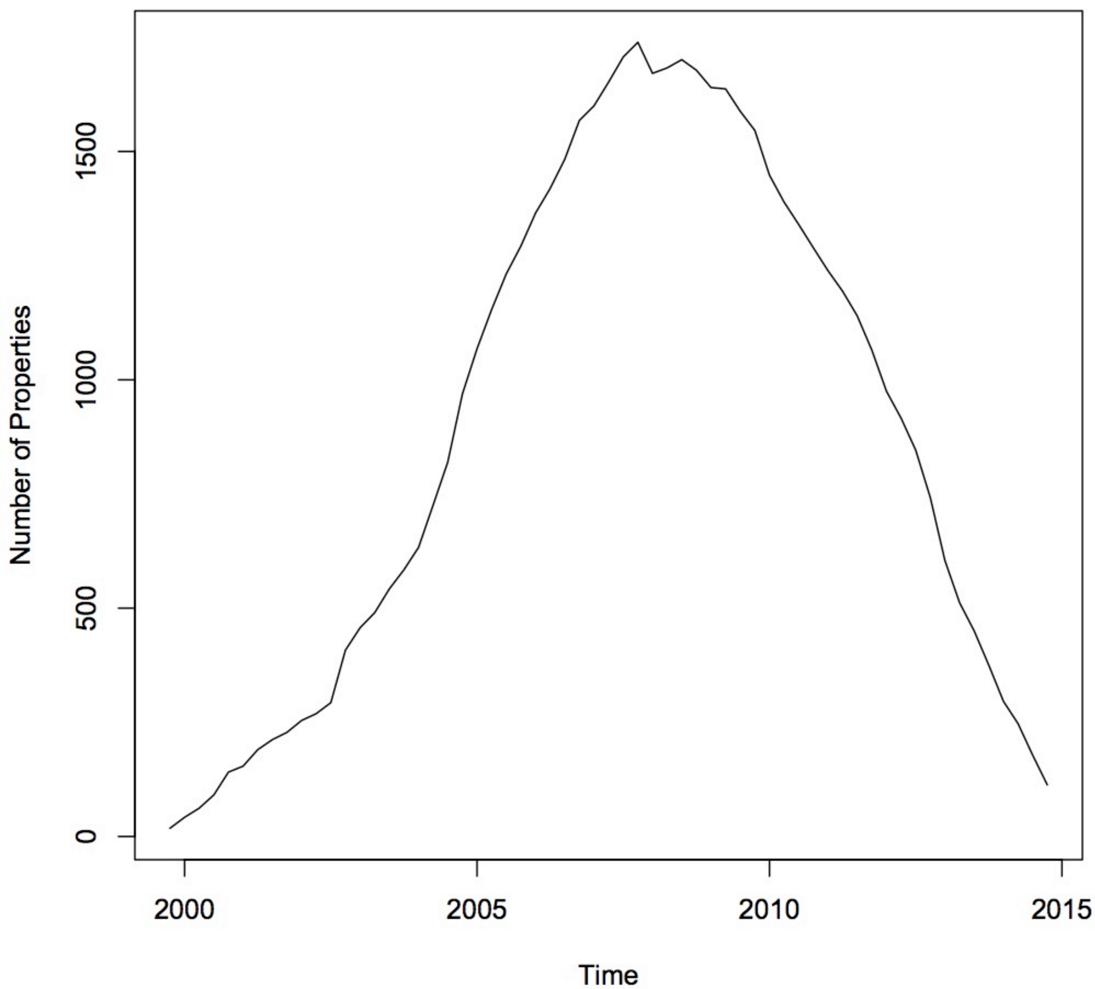

Figure 2. Histogram of property cap rates (calculated from gross rental income)

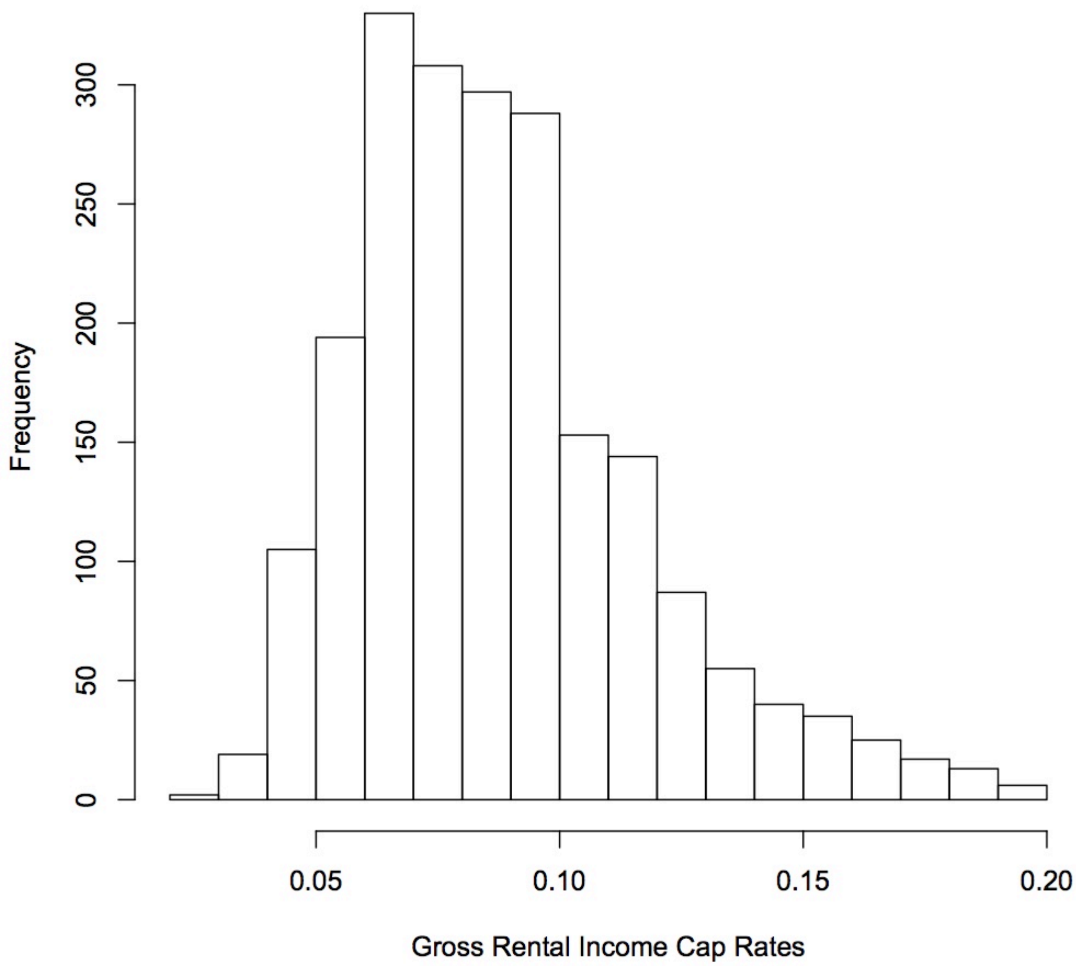

Figure 3. Histogram of property cap rates (calculated from net operating income)

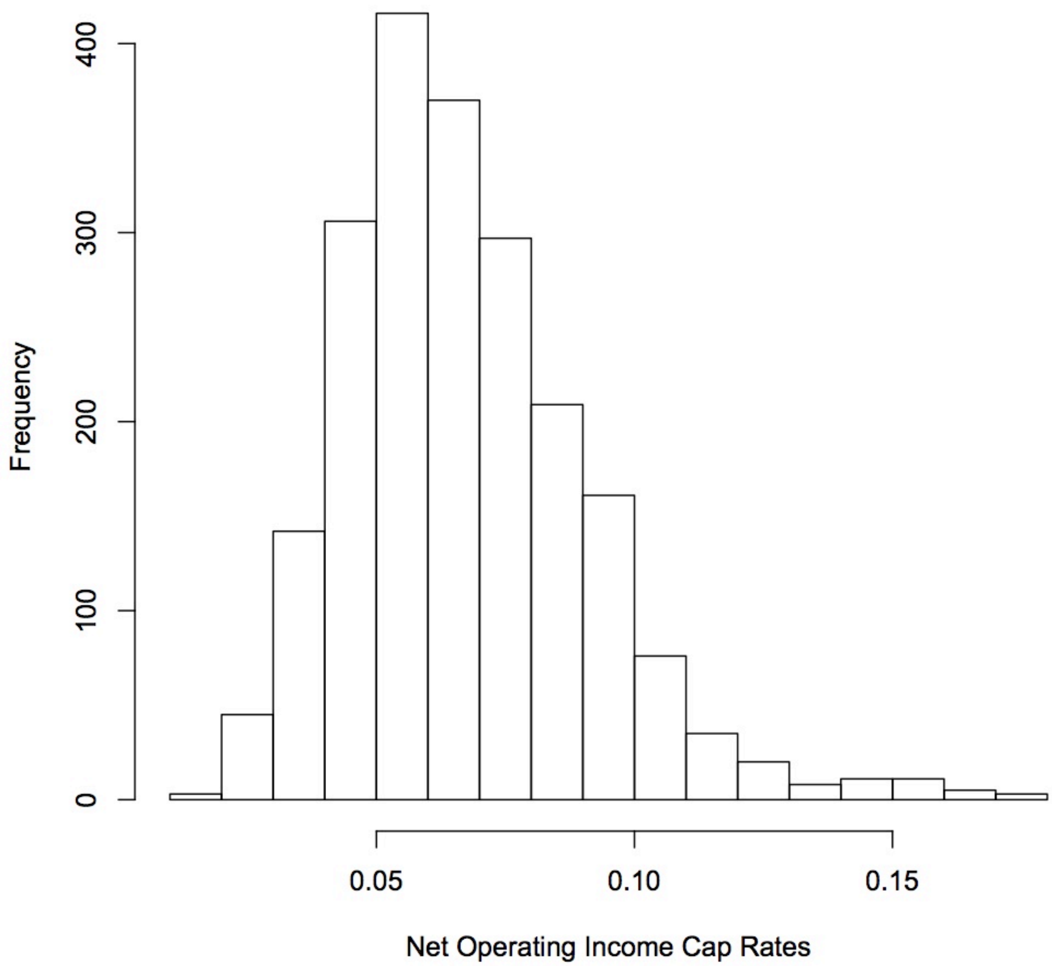

Figure 4. Histogram of annual total return MIRRs